EVIDENCE FOR GLACIATION IN ELYSIUM; Duwayne M. Anderson, Gary W. Brandstrom, Texas A&M University

Evidence for the existence of permafrost and the surface modification due to frost effects and the presence of ice on Mars dates from early observations by Otterman and Bronner (1), Leighton and Murray (2), Anderson et al. (3), Baranov (4) and Anderson and Gatto (5). The Viking landers I and II confirmed the presence of water in the regolith and the periodic occurrance of frost at the surface of Mars, Bieman et al. (6), Anderson (7). Observations from the Viking Orbiters I and II demonstrated the presence of atmospheric water at various concentrations in the atmosphere of the planet (Farmer et al. [8]) and also provided a means of documenting the accumulation and sublimation of frost and ice in the two polar caps and at several other locations on the planet. Later analysis of the Viking Orbiter imagery produced evidence suggesting the former presence of ice sheets that could have played a part in shaping the surface of Mars (Lucchitta et al. [9]). Similarities have been pointed out between a number of streamlined Martian channel features and similar streamlined landforms created by antarctic ice sheet movements.

A study of Viking Orbiter imagery of Granicus Valles and the surrounding terrain in Elysium has produced further evidence of glaciation on Mars. Granicus Valles is located in the Northern hemisphere between 25 degrees and 40 degrees latitude and 220 degrees to 240 degrees longitude. It extends from the Elysium fossae near Elysium Mons to Utopia planitia, the plains where Viking Lander II is located. Granicus Valles has been characterized as an outflow channel (Malin [10], Carr [11]). It is approximately 1100 km long, about 10 km wide at the source, with distributory branches that cover an area approximately 300 km wide. Three distinctly different geological units are involved (Mouginis-Mark [12], Christiansen and Greeley, [13]). Part of the region is characterized as a Complex Vent Area. It is one of the main volcanic centers in Elysium. Another has been referred to as Modified Lava Plain by Christiansen and Greeley (13), and Compound Lava Plains and Erosional Plains by Mouginis-Mark (12). A portion of it was earlier referred to as Channeled Plain by Christiansen and Greeley (13).

Volcanism has played an important role in developing the landscapes of the Elysium region. Two features that strongly resemble terrestrial moberg ridges have been found. These features are ridge shaped, serrated mountains, very similar to the moberg ridges described by Allen (14). Terrestrial moberg ridges form as a result of subglacial, fissure eruptions. The only apparent difference between those observed on earth and these two Martian counterparts is scale; the Martian features are much larger. Because the size of a moberg ridge is limited by the thickness of ice above the erupting fissure lava, the greater height of the Martian ridges implies a much thicker ice sheet. The height of the moberg ridge near Granicus Valles is about 2.6 km, indicating that the preexisting ice sheet was at least 2.6 km thick. The ground surface surrounding both Martian moberg ridges appears to have two distinct levels; it is lowest at the base of the ridges, rising to a level near the top of the ridges at a distance. A possible explanation is that subsidence occurred during formation of the Martian moberg ridges due to the melting of ground ice near the eruption area while at a distance most of the ground ice in the permafrost is still present and the original elevation has been preserved. Meltwater during and following eruptions might have been suddenly released during subglacial volcanism into Granicus Valles in one case and into Hrad Valles in the other. Fluvial erosion thus could have played a role in shaping both.

Crater size-frequency plots indicate differences in the ages of surfaces from one region to another, ranging from one to three billion years. The presence of a thick ice sheet together with underlying permafrost could help to explain this. A thick mantle of ice would have intercepted and contained many meteoric impacts, shielding the underlying regolith. Subsequent removal of this ice by sublimation or melting would then expose a relatively unmarked surface to subsequent meteoric bombardment. These surfaces, from crater size-frequency plots, would always appear younger than the surrounding, continuously exposed terrains.

Many of the volcanic edifices in Elysium appear to have uncommonly steep slopes at their bases. Many are quite large and probably stood above the hypothetical, pre-existing ice sheet. Volcanic flows and ejecta cascading down slope would have come to rest on the surrounding ice. Later disappearance of the ice would result in the subsidence and redeposition of these materials, helping to explain the abnormally steep basal slopes now evident.

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